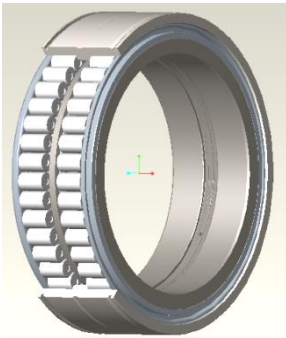


BEARINGS FOR WIND TURBINES



Quality Bearings for Wind Turbines

Wind turbine technology continues to progress for increased efficiency, reliability and longer service life of equipment. Innovative bearing designs from URB are instrumental in these improvements and spreading the use of wind technology for electrical power generation.

URB engineers can help specify the bearing type, size to meet critical customer requirements and industry regulations.

URB supplies a wide range of bearings to specialized industries, including the following commonly used types for wind energy applications:

Cylindrical roller bearings

- Suitable for high radial loads;
- Multi-row and full complement versions available for even higher radial loads;
- Special specifications (optimized geometry) and customized designs available;
- Special cylindrical roller bearing, single row, without outer ring, with crowning inner ring profile;
- For both gearboxes and generators.

| Type bearing | Dimensions mm | | | Basic radial kN | | Weight kg |
|---------------|------------------|-----|-----|--------------------|-------|--------------|
| | d | D | B | dyn. | stat. | |
| NU2218 EMASQ1 | 90 | 160 | 40 | 242 | 314 | 3.58 |
| NJ2220 EMSQ1 | 100 | 180 | 46 | 319 | 418 | 5.22 |
| NJ2320 EMSQ1 | 100 | 215 | 73 | 570 | 717 | 13.94 |
| NU2320 EMSQ1 | 100 | 215 | 73 | 570 | 717 | 13.71 |
| NJ2222 EMSQ1 | 110 | 200 | 53 | 383 | 516 | 7.75 |
| NU2222 EMSQ1 | 110 | 200 | 53 | 383 | 516 | 7.22 |
| NU222 EMSQ1 | 110 | 200 | 38 | 279 | 343 | 5.29 |
| NJ2322 EMASQ1 | 110 | 240 | 80 | 667 | 868 | 19.36 |
| NJ322 EMSQ1 | 110 | 240 | 50 | 443 | 513 | 11.66 |
| NJ2324 MC3SQ1 | 120 | 260 | 86 | 702 | 907 | 23.22 |
| NJ2224 EMSQ1 | 120 | 215 | 58 | 446 | 609 | 9.16 |
| NU2224 EMSQ1 | 120 | 215 | 58 | 446 | 609 | 9.16 |
| NJ324 EMSQ1 | 120 | 260 | 55 | 549 | 644 | 14.99 |
| NU326 EM6SQ1 | 130 | 280 | 58 | 607 | 722 | 18.49 |
| NJ2226 EMSQ1 | 130 | 230 | 64 | 523 | 726 | 11.83 |
| NU2226 EMSQ1 | 130 | 230 | 64 | 523 | 726 | 11.6 |
| NJ2326 EM6SQ1 | 130 | 280 | 93 | 909 | 1212 | 29.44 |
| NU2326 EM6SQ1 | 130 | 280 | 93 | 909 | 1212 | 28.97 |
| NU226 EMSQ1 | 130 | 230 | 40 | 356 | 443 | 7.1 |
| NJ228 EMSQ1 | 140 | 250 | 42 | 372 | 479 | 9.24 |
| NU2228 EM6SQ1 | 140 | 250 | 68 | 543 | 780 | 15.22 |
| NU2328 EMASQ1 | 140 | 300 | 102 | 1130 | 1589 | 35.5 |
| NJ2230 EMSQ1 | 150 | 270 | 45 | 631 | 922 | 19.22 |
| NJ2330 EMASQ1 | 150 | 320 | 108 | 1223 | 1710 | 45.64 |
| NU330 EMASQ1 | 150 | 320 | 65 | 798 | 988 | 27.85 |
| NU230 EMSQ1 | 150 | 270 | 45 | 422 | 550 | 11.67 |
| NJ2332 EMSQ1 | 160 | 340 | 114 | 1312 | 1819 | 52.183 |
| NJ2232 EMSQ1 | 160 | 290 | 80 | 767 | 1109 | 24.51 |
| NU2232 EMSQ1 | 160 | 290 | 80 | 767 | 1109 | 24.15 |
| NU232 EMSQ1 | 160 | 290 | 48 | 498 | 666 | 14.61 |
| NU2234 EMASQ1 | 170 | 310 | 86 | 914 | 1316 | 28.57 |
| NJ2334 EMSQ1 | 170 | 360 | 120 | 1226 | 1758 | 62.08 |
| NJ234 EMSQ1 | 170 | 310 | 52 | 618 | 828 | 19.22 |
| NU2336 EMSQ1 | 180 | 320 | 86 | 955 | 1408 | 30.48 |
| NU2338 EM6SQ1 | 190 | 400 | 132 | 1789 | 2628 | 85.7 |
| NJ2240 EMSQ1 | 200 | 360 | 98 | 1220 | 1860 | 43.599 |
| NU2240 EMSQ1 | 200 | 360 | 98 | 1220 | 1860 | 42.83 |
| NU1048 MSQ1 | 240 | 360 | 56 | 695 | 1168 | 21.19 |
| NU1068 MSQ1 | 340 | 520 | 82 | 1117 | 1817 | 62.7 |

| | | | | | | |
|-------------------------|-----|----------|------|------|------|--------|
| NNF5013 VS094FW99A-2RSR | 65 | 100 | 46 | 134 | 236 | 1.28 |
| NNF5017 VS094FW99A-2RSR | 85 | 130 | 60 | 281 | 456 | 2.78 |
| NNF5018 VS094FW99A-2RSR | 90 | 140 | 67 | 307 | 546 | 3.61 |
| NNF5022 VS094FW99A-2RSR | 110 | 170 | 80 | 395 | 724 | 6.39 |
| NNF5034 VS094FW99A-2RSR | 170 | 260 | 122 | 1059 | 2059 | 22.11 |
| NNF260 VS094FW99A-2RSR | 260 | 340 | 95 | 983 | 2028 | 21.7 |
| NNF5024 VS094FW99A-2RSR | 120 | 180 | 80 | 412 | 780 | 6.84 |
| NNF5028 VS094FW99A-2RSR | 140 | 210 | 94 | 681 | 1234 | 10.77 |
| 604533-00162/2 | 420 | 506.726* | 55 | 1010 | 2350 | 16.284 |
| 604533-00163/2 | 240 | 287.954* | 32 | 333 | 735 | 3.617 |
| 604533-00164 | 217 | 259.47* | 29 | 280 | 595 | 2.612 |
| 604533-00168/2 | 270 | 322.14* | 38 | 460 | 950 | 5.126 |
| 604533-00169 | 300 | 356.575* | 38 | 485 | 1060 | 6.33 |
| 604533-00170 | 325 | 383.42* | 43 | 600 | 1330 | 7.799 |
| 604533-00171/2 | 375 | 406.5* | 48 | 830 | 1860 | 12.402 |
| 604533-00172/2 | 485 | 575.13* | 66 | 1340 | 3200 | 28.350 |
| 604533-00214 | 25 | 53.55* | 28 | 79 | 77 | 0.263 |
| 604533-00215 | 30 | 60.49* | 28 | 91 | 94 | 0.333 |
| 604533-00216/2 | 30 | 68.15* | 31.5 | 114 | 112 | 0.496 |
| 604533-00217/2 | 35 | 73.02* | 35 | 136 | 145 | 0.613 |
| 604533-00218/2 | 40 | 81.4* | 37.5 | 165 | 199 | 0.849 |
| 604533-00219/2 | 45 | 93.47* | 45 | 220 | 264 | 1.341 |
| 604533-00220/2 | 50 | 109.27* | 50 | 268 | 286 | 1.92 |
| 604533-00221 | 80 | 147.14* | 67.5 | 468 | 629 | 4.451 |
| 604533-00222/2 | 70 | 134.75* | 60 | 408 | 489 | 3.361 |
| 604533-00223/2 | 80 | 147.14 | 67.5 | 468 | 629 | 4.451 |
| 604533-00224/1349696 | 90 | 176.21 | 80 | 636 | 780 | 7.319 |
| 604533-00228/2 | 550 | 652.2* | 55 | 1420 | 2900 | 28.126 |
| 604533-00229 | 110 | 233.7* | 100 | 1045 | 1280 | 17.693 |
| 604533-00231/2 | 600 | 690.05* | 60 | 1470 | 3850 | 32.819 |
| 604533-00233/2 | 50 | 109.27* | 50 | 220 | 206 | 1.83 |
| 604533-00236/2 | 40 | 81.4* | 37.5 | 132 | 140 | 0.799 |
| 604533-00239/2 | 30 | 60.49* | 28 | 70 | 66 | 0.318 |

* E dimensions

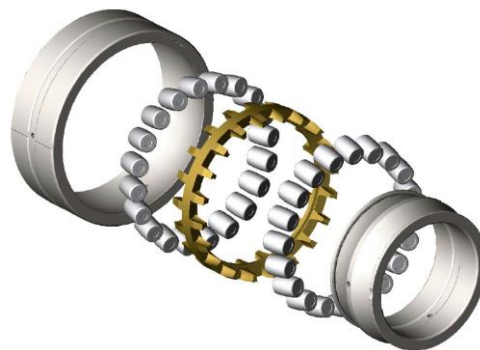


Cylindrical roller bearings are very often used because of their high radial load capacity. The ability to accommodate angular misalignment is limited and has to be considered according to the manufacturers guidelines. The bearings with black oxide-coated offers protection at corrosion and substances, thus they have a good behavior at harsh environments. Appropriate condition for axial loading is achieved when the axial to radial load ratio F_a/F_r is less than 0.4 and viscosity ratio κ is higher than 2.

Spherical roller bearings

- Suitable for large radial loads and low to medium speeds;
- Allows compensation for misalignment;
- Usually for main shafts and gear;

| Type bearing | Dimensions mm | | | Basic radial kN | | Weight kg |
|--------------|---------------|-----|-----|-----------------|-------|-----------|
| | d | D | B | dyn. | stat. | |
| 22217 MBW33 | 85 | 150 | 36 | 230 | 295 | 2.75 |
| 22319 MBW33 | 95 | 200 | 67 | 570 | 740 | 9.97 |
| 22320 MBW33 | 100 | 215 | 73 | 670 | 880 | 13.78 |
| 22322 MBW33 | 110 | 240 | 80 | 800 | 1060 | 18.7 |
| 22324 MBW33 | 120 | 260 | 86 | 930 | 1230 | 23.18 |
| 22226 MBW33 | 130 | 230 | 64 | 600 | 880 | 11.47 |
| 22326 MBW33 | 130 | 280 | 93 | 1080 | 1450 | 28.25 |
| 22234 MBW33 | 170 | 310 | 86 | 1080 | 1610 | 27.51 |
| 23134 MBW33 | 170 | 280 | 88 | 990 | 1650 | 21.41 |
| 24134 CAW33 | 170 | 280 | 109 | 1280 | 2230 | 27.41 |
| 24136 CAW33 | 180 | 300 | 118 | 1460 | 2590 | 32.96 |
| 23238 MBW33 | 190 | 340 | 120 | 1610 | 2640 | 47.83 |
| 23240 MBW33 | 200 | 360 | 128 | 1620 | 2590 | 57.7 |
| 24144 MBW33 | 220 | 370 | 150 | 1780 | 3109 | 65.44 |
| 23244 MBW33 | 220 | 400 | 144 | 1850 | 2899 | 80.62 |
| 23948 MBW33 | 240 | 320 | 60 | 600 | 1170 | 13.32 |
| 23152 MBW33 | 260 | 440 | 144 | 2025 | 3391 | 88.93 |
| 23956 MBW33 | 280 | 380 | 75 | 880 | 1749 | 24.76 |
| 23960 MBW33 | 300 | 420 | 90 | 1263 | 2495 | 39.23 |
| 23964 MBW33 | 320 | 440 | 90 | 1225 | 2468 | 40.92 |
| 23064 MBW33 | 320 | 480 | 121 | 1808 | 3471 | 77.84 |
| 23972 MBW33 | 360 | 480 | 90 | 1312 | 2792 | 46.22 |
| 23984 CAW33 | 420 | 560 | 106 | 1830 | 4060 | 73.19 |



Spherical roller bearings have a high radial loading capacity and can accommodate a higher degree of misalignment. The experiences in wind turbine gearboxes are at the time not unambiguous. Consequently the operating conditions such as the ratio F_a/F_r , and the ratio between roller diameter and roller length, low radial loads as well as the risk of a considerable amount of skidding has to be carefully evaluated.

Calculation of rating life

For a preliminary selection of bearings in the design process of the gearbox, the basic rating life calculation should be used according ISO 281.

$$L_{10h} = \frac{10^6}{60 \cdot n} \left(\frac{C}{P} \right)^p$$

where

L_{10h} is basic rating life, hours;

n is rotational speed, rpm;

- C* is basic dynamic load rating according to ISO 281, N;
P is dynamic equivalent bearing load, N;
p is life exponent (3 for ball bearings and 10/3 for roller bearings).

Minimum basic rating life, L_{10h}

| Bearing position | Required life, L_{10h} , hr |
|--------------------------------------|-------------------------------|
| High speed shaft | 30,000 |
| High speed intermediate shaft | 40,000 |
| Low speed intermediate shaf | 80,000 |
| Planet | 100,000 |
| Low speed shaft | 100,000 |

Note:
Values in this table are valid for a design life of 20 years and shall be adjusted for designs with different design life.

Advanced rating life (L_{adv})

The method to determine rating life L_{adv} is described in DIN ISO 281 Beiblatt 4/ ISO/TS 16281:2008.

The main influences that shall be considered in an advanced life calculation are:

- Radial, axial, and moment loads;
- Load sharing between rolling elements;
- Load distribution along the roller length considering actual roller and raceway profiles;
- Load distribution on flanges of bearings;
- Elasticity of bearing, shaft and housing;
- Internal design of the bearing, hereunder roller- and raceway profiling;
- Truncation of contact area;
- Operating misalignment between inner and outer rings;
- Operating internal clearance considering initial clearance, shaft and housing fit, and temperature of inner and outer rings;
- Operating lubricant viscosity and required lubricant viscosity for full hydrodynamic lubrication condition;
- Operating lubricant cleanliness;
- Performance of additive package;

Such advanced methods shall be used in the design phase of a wind turbine gearbox. The advanced rating life shall be greater than the specified design life of the wind turbine.

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